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The geography of homicide in São Paulo, Brazil

Vânia Ceccato
Institute of Criminology, University of Cambridge, Sidgwick Avenue, Cambridge CB3 9DT, England; e-mail: vac29@cam.ac.uk

Robert Haining
Department of Geography, University of Cambridge, Cambridge CB2 3EN, England; e-mail: rph26@cam.ac.uk

Tulio Kahn
Department of Planning and Analysis, Secretaria de Segurança Pública de São Paulo, Brazil; e-mail: tkahn@sp.gov.br
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Abstract. The authors investigate geographical patterns of homicide in São Paulo, Brazil. The geography of crime in developing world cities has been an underresearched area in part because of the lack of good-quality, geocoded offence data. In the case of São Paulo the availability of a new digital police dataset has provided the opportunity to improve our understanding of its crime patterns. The authors report the testing of hypotheses about the spatial variation in homicide rates. This variation is explained by poverty, situational conditions determined by differences in land use, and processes that indicate links with the geography of drug markets and the availability of firearms.

1 Introduction

São Paulo is one of the most unsafe cities in the world. It is 107th in the 2004 quality-of-life classification of 215 major cities worldwide, and criminality is the factor that impacts most negatively on the city's rank (Mercer Human Resources, 2004). The metropolitan area of São Paulo included three of the most violent areas in Latin America during the 1990s, with some districts having 140 homicides a year per 100 000 inhabitants (Inter-American Development Bank, 2000). Although homicide rates have been falling for the last five years, the police in São Paulo recorded an average of thirteen a day between 1999 and 2003. As in many other parts of the world, victims of homicide in São Paulo are often young males but only 3% of the killings are committed by individuals aged 18 years or less (Lima, 2002). Firearms were used in most cases, and the intention to kill was evidenced by the choice of the head as the main target. From a sample of 1492 bodies, 42% tested positive for alcohol and less than 1% for cocaine (Gawryszewski et al, 2004).

European and American criminology research has revealed strong associations between structural and cultural factors and violent crime at the intraurban level (for a review, see Heitmeyer and Hagan, 2003; Smith and Zahn, 1999). However, relatively little is known about associations within cities in developing countries. Until recently, spatial analysis of such cities was rare because offence data either were not available or were of low quality. A feature of the present study is that it is based on a new large georeferenced crime database for São Paulo that has only become available since 2000. The analysis of such a large database was made feasible by the use of geographic information systems technology.

Previous studies in São Paulo, by Carneiro (1999), Lima (2002), Camara et al (2001), and Cardia et al (2003), have focused on links between deprivation and violent crime, whilst suggesting the need to include other factors. In this paper we examine

this relationship for the case of homicide whilst also allowing for the existence of criminogenic conditions generated by the availability of weapons, drug-related offences, and alcohol consumption. We also control for situational factors generated by different land uses.

The structure of this paper is as follows. In section 2 we provide definitions and discuss data issues. Drawing on the available literature, the factors expected to explain homicide rates at the intraurban level are summarised in section 3. In section 4 we describe why São Paulo constitutes a particular case study, and propose a theoretical framework for the analysis. After the calculation of standardised homicide ratios, in section 5 we examine the relationship between homicide patterns and neighbourhood characteristics. In section 6 we discuss directions for future work.

2 Definitions and issues on data quality

Homicide is defined according to the Brazilian Penal Code as "to kill someone" (article 121). In this analysis homicide is regarded as intentional killings, which are recorded as *homicidio doloso*. This category excludes death following rape, robbery, or confrontation with the police, death in (traffic) accidents, and so-called 'found bodies'.[1] However, there are cases in which it is difficult to ascertain the event that led to the death of the victim (Felson, 1993; Miethe and Drass, 1999) so there may be homicides due to expressive or instrumental crimes which are misclassified as *homicidio doloso*.

Violence, including homicide, can be categorised in different ways: by the individuals who suffer the violence (for example, young people, the elderly); by the agents of the violence (for example, individuals, gangs, crowds); by the nature of the aggression (for example, psychological, physical, or sexual); by the motive (for example, political, racial, economic, instrumental, emotional); and by the relationship between offender and victim—relatives, friends, acquaintances, or strangers (Buvinic et al, 1999). However, records of *homicidio doloso* in this study cannot be categorised in such detail from the police database. The database of the Instituto Médico Legal (IML) holds data on people killed by nonnatural causes as well as some information on offenders and their motives.

There are four primary sources for crime data in Brazil: police official statistics, health-related statistics, victimisation surveys, and, in the case of homicide, civil registry records. Compared with other offence statistics, those related to homicide are among the most accurate since there is no significant variation in the way it is classified and homicide is, in many cases, cross-reported by several institutions.

The most common source of data on crime is the police. The so-called '*Boletim de Ocorrênica*' (BO), comes from the civil police and refers to the first record made by the police—either when the event occurs or is discovered. Police in São Paulo comprise three bodies: the metropolitan police (local metropolitan guard, responsible for public order) and, with more power, the civil and military police, which are state institutions. It is the state police who deal with crime: the civil police produce the records which the statistics are based on and investigate occurrences that may be sent to the judiciary. Despite keeping an offence register of their own (*Relatório de Ocorrência*), the military police deal strictly with street policing and crime prevention. The register of homicides from the civil and the military police do not coincide, and according to Caldeira (2000) the civil police counts are usually lower than the military police data. For all unnatural deaths (including car accidents), the IML has a parallel database containing detailed data which relate to the cause of death. However, this cannot yet be matched to police databases.

[1] The category 'found bodies', includes cases in which the individual has been killed by natural causes, but also bodies dumped after a violent attack.

Police data on murders are quite robust, but they are not problem free. Police records provide the place where the victim was found, but this location may be where the killing took place or where the body was dumped. Police homicide data are an underestimate. Police records refer to the event, not the total number of victims. Multiple murders (so-called *chacinas*) are not rare events in São Paulo (3% of total homicides a year). According to police records from 2003, 'revenge' is the most common reason behind these multiple murders (52.2%) followed by problems related to drug trafficking (21.4%). Most of these killings take place in the southern parts of the city, so there is a geography to this underestimation. Another problem is that when a body is found the cause of death may sometimes not be clear. According to Carneiro (1999), inconsistency in the way the police classify deaths may be significant at times of political tension. People killed by the police are not registered as victims of homicide: these deaths are registered as 'resistance followed by death'. Police killings in 1992 represented 20.6% of total homicides (compared with 1.2% in New York city), which reflects the police policy in the 1990s of being tough on crime. By 2003, police killings, despite still being relatively high, had been reduced to 8% of total homicides. It is not surprising, therefore, that crime data in Brazil are class and gender biased (Caldeira, 2000).

Despite these structural distortions, the way that the statistics are systematised by the police in São Paulo has improved greatly during recent years. One example is the implementation in 2000 of INFOCRIM—an automated system of criminal records at coordinate level run by the Public Security Secretary of São Paulo. Nowadays, due to improvements in quality-control procedures, only 20% of crime records have some quality deficiency (figure 1). This includes all types of inconsistencies in the BOs, such as double crime codes, wrong or missing crime type, location, or time of the event. That problems still remain is partly because different police officials may have slightly different approaches to recording a crime. Some of these inconsistencies are identified by a group of experts who run data controls by sampling 10% of crimes every day.

In the case of homicide, the INFOCRIM database contains data on the nature of the offence, name of the victim, and where the victim was found. Although there is often uncertainty about where the event took place, evidence shows that homicide is generally a local phenomenon. For instance, a sampling of 2671 homicide records from IML shows that in São Paulo victims are killed either in the district where they

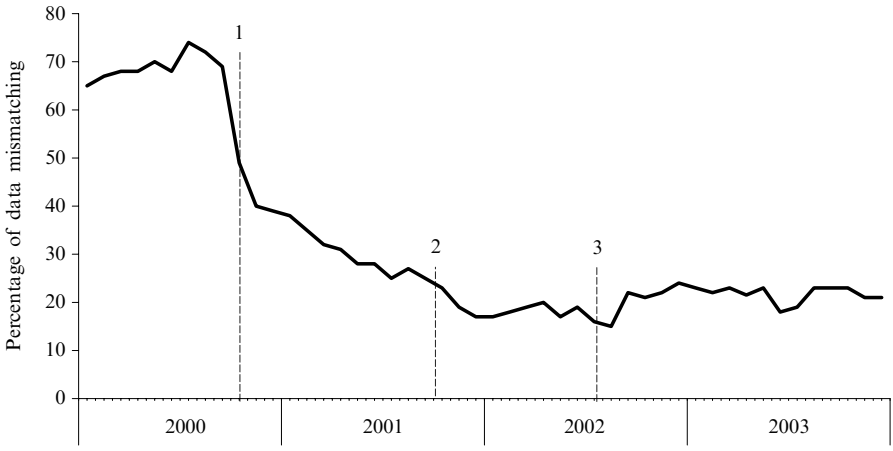


Figure 1. Percentage of data mismatching since implementation of INFOCRIM. The three sections refer to different routines of data quality control. Source: Secretaria de Segurança Pública, 2004.

live (51%) or very close to it (24%). INFOCRIM also includes temporal data: on the approximate hour, day, and year the murder occurred, as well as the time the offence was reported. However, checks of the data show that the estimated hour of death is often similar to the one when the offence is recorded. According to the INFOCRIM control data service, the time gap between the murder and the recording often varies but it is difficult to ascertain an exact time for the murder without a close examination of the body.

Health-related statistics and victimisation surveys can also be used as a source for crime data in Brazil. Data on homicides, for instance, can be obtained from the Ministry of Health. Homicides are extracted by selecting only the deaths with external causes and under intentional circumstances, although no information on the intention is provided. There are indications that these data are more accurate than the police statistics since they are based on the reporting of deaths and not on whether a crime occurred; however, the two are highly correlated (Carneiro, 1999). Although victimisation surveys are good indicators of the reliability of police statistics, they are not carried out systematically: more commonly, victimisation surveys cover only the largest metropolitan areas in Brazil. The last victimisation survey was carried out in 2002 and covered São Paulo, Rio de Janeiro, Recife, and Vitória (GSI/ILANUD/FIA-USP, 2002).

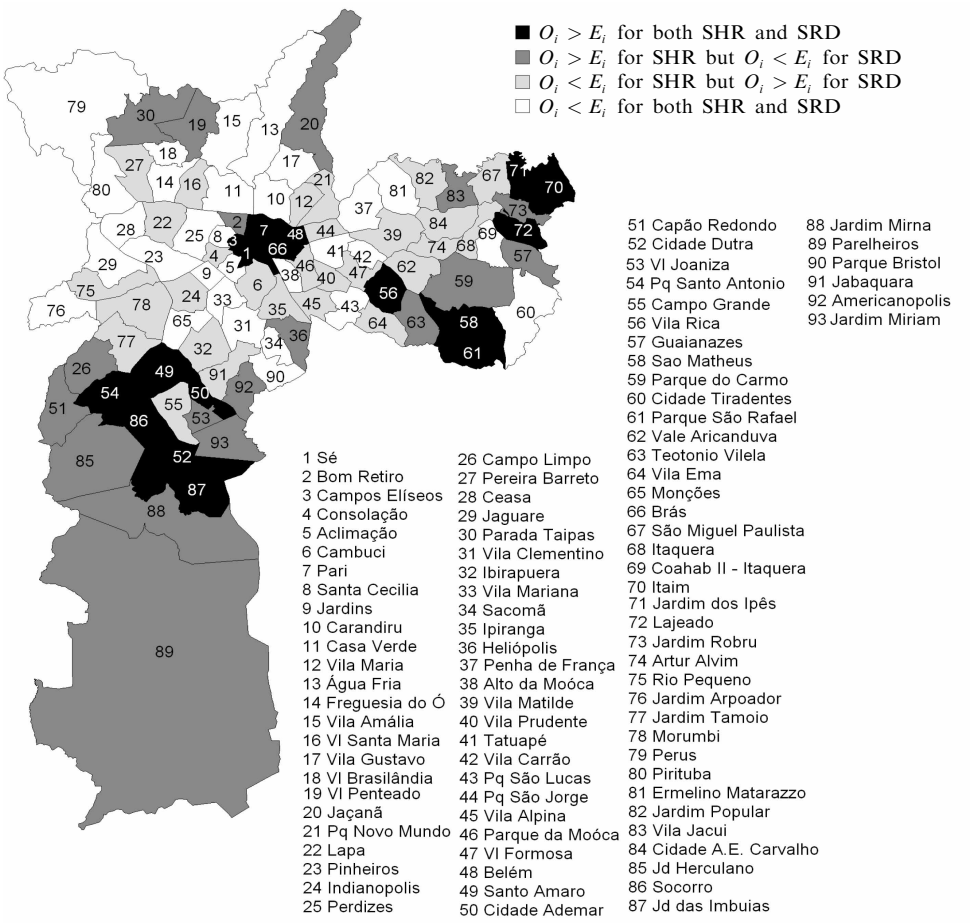


Figure.2. Standardised homicide ratios (SHR) and standardised robbery followed by death ratios (SRD) for São Paulo police districts: comparing observed (O_i) with expected (E_i) counts.

In this study we used three data sources: the police official database (INFOCRIM, from 1999 to 2003) aggregated by police districts (figure 2); the detailed data sample from IML (2002–03); and the 2002 victimisation survey (GSI/ILANUD/FIA-USP, 2002). The IML individual data and victimisation survey were only used to complement the police database (for example, to provide information on circumstances such as the presence of drugs, alcohol, type of weapon used, target, as well as personal details).

Data from Fundação IBGE—Census Bureau were used to draw the socioeconomic and demographic profiles of the districts of São Paulo. Data from the year 2000 by census tracts were used. Health data at the coordinate level (individuals with long-term alcohol problems) were obtained from DATASUS 2001 (Ministry of Health) and were then aggregated to the Police district level (figure 2).

3 Explaining variation in homicides rates at the intraurban level

Much of the research in this area is based on work carried out in North America (United States) and Western Europe (especially the United Kingdom), and the following discussion draws heavily on this (except where otherwise stated).

Demographic composition is known to be a good predictor of the level of violence, especially in deprived areas. The highest homicide rates are registered for the young male population (Fox and Piquero, 2003; Yunes and Zubarew, 1999).

Social factors are important. Social disorganisation theory links many forms of crime with the presence of weak informal social controls (Craglia et al, 2001; 2005; Kornhauser, 1978; Shaw and McKay, 1942; Wilson, 1987). High homicide rates are a sign of severe social disorder. In these areas, residents have less access to jobs and less exposure to conventional role models, and relatively few working-class and middle-class households to serve as buffers against the effects of uneven and poor economic conditions (Krivo and Peterson, 1996). Some argue that the effect of poverty per se in generating violence is not as important as the impact of 'relative deprivation' (Burton et al, 1994). In this version of the theory, the fact that a group is relatively deprived in comparison with others provides the conditions for conflict and violence.

Cultural differences in values, norms, and beliefs held by members of groups or subgroups are seen as important in explaining variation in rates of violence, particularly in the United States (Messner and Rosenfeld, 1999). The core idea is that some subcultures provide greater normative support than others for violence—in upholding values such as honour, courage, and manliness [for example, see, Wolfgang and Ferracuti (1967); for an extensive review of cultural and subcultural theories of homicides, see Corzine et al (1999)]. The existence of profound differences in levels of violence between ethnic groups is a controversial field (Blau and Blau, 1982; Farrington et al, 2003), and effects become entangled with the social and economic characteristics of the different groups (as shown by Kilsztajn et al, 2003, in the context of Brazil). Sampson and Wilson (1995) include both structural and cultural factors in explaining violence, arguing that low residential quality creates social isolation and a concentration of the disadvantaged. This leads to cultural adaptations that undermine social organisation and attempts to control crime. In such circumstances, homicide may become a means of imposing social control by dominant members of the group (Black, 1984). In social contexts in which there is little or no access to dispute-resolution structures (for example, courts for small cases, housing associations, trade unions) or agents of dispute mediation (for example, lawyers, community representatives), violence may be seen as the only possible means by which to solve a problem. Kubrin and Weitzer (2003), suggest that police practices play an important role as generators of violence. In Latin America, for instance, inadequate control of the police and abusive treatment of

residents in poor areas lead to violent conflicts and foster community alienation (Cardia et al, 2003; Chevigny, 1999; 2003).

Situational or structural factors, particularly differences in land use, play an important role in helping us to understand the distribution of violent crime in a city. Land use shapes the flows of human routine activities and affects the number of interactions that are criminologically relevant and which could lead to offences (Cohen and Felson, 1979; Gartner, 1990; Wikström, 1991). In the case of lethal violence, evidence suggests that primary homicide takes place in private places, mostly in poor neighbourhoods (Kubrin, 2003; Parker and Smith, 1979) whereas nonprimary homicides (for example, killings associated with robbery) take place in public places and areas with mixed land use—typical of urban cores, and where most violent alcohol-related crimes also take place (Bromley and Nelson, 2002). The presence of alcohol,[2] and the availability of weapons (Felson and Messner, 1996) and drugs increases the likelihood that certain types of confrontational interaction escalate into a killing.

Goldstein (1985) provides insight into the dynamics of the drug–homicide linkage. This author suggests three ways in which drugs and drug trafficking may be causally related to violence. The first kind of violence is *psychopharmacological*—caused by the properties of the drug itself. The second is *economic-compulsive*—motivated by the need or desire to obtain drugs, and the third is *systemic* violence, which is associated with traditionally aggressive patterns of interaction within the system of drug distribution and use. Baumer et al (1998) confirm that areas in the United States with higher levels of crack-cocaine use also have higher homicide rates as well as higher levels of other offences such as robbery. Empirical evidence in the United States shows that in drug-related homicides the perpetrator is commonly unknown, and that most of the these are classified as 'systemic, involving territorial disputes, robbery of a dealer, or drug debts' (Goldstein et al, 1989). More than half of drug-related homicides take place in areas known to be locales for drug sales, whereas only 10% of non-drug-related homicides take place in these areas (Brownstein et al, 1992).

In the next section we discuss how the factors discussed above are expected to impact on São Paulo, also pointing out aspects that make São Paulo distinctive compared with other parts of the world including, in some respects, other large cities in Latin America.

4 Framing São Paulo as the case study

4.1 Previous research findings

São Paulo experiences high levels of violence—by national as well as international standards. Homicide rates in the municipality have varied between 40 and 53 per 100 000 inhabitants over the last five years, but higher rates can be found in some municipalities within the metropolitan area: over 100 per 100 000 inhabitants [Brazil has about 30 000 homicides a year, one of the highest rates in the world (UN, 2003)]. São Paulo's homicide rates have only recently been exceeded by those of the capital cities of Vitória (Southeast Brazil), Porto Velho (North Brazil), and Recife (Northeast Brazil). Deprived areas in the central and peripheral parts of the city show the highest number of killings over the year. As many as 54% of homicides reported between 2000 and 2002 took place at weekends, and 44% between 20.00 and 02.00—mostly outdoors (70% in streets) but close to the victims' homes. Conflicts often reach a peak during the hot months of the year (Ceccato, 2005).

[2] Although most of the literature looking at the relationship between alcohol and lethal violence does not focus on intraurban variations, they corroborate such relationships (for example, Baumer et al, 1998; Fagan, 1990; Parker, 1993; Rossow, 2001).

We turn now to some of the characteristics of São Paulo that are thought to be important in criminogenic terms. São Paulo's size is unique even within Latin America. It is Brazil's largest municipality and constitutes South America's largest metropolitan area. In 2003 the municipality of São Paulo had over ten million inhabitants and the greater metropolitan area had nearly eighteen million. There is a confirmed link between the numbers of young males and homicide rates in São Paulo (Cardia et al, 2003; Lima, 2002). The city is also very compact in international terms, having about 21 000 inhabitants per square mile. It is characterised by having experienced periods of rapid urban growth accompanied by a lack of planning, and evident marginalisation of significant segments of its society (Rolnik, 2001). Population density has criminogenic implications through its effect on social interactions.

São Paulo's ethnic composition and how this relates to levels of violence differ in some important respects from other cities in the world. Although the homicide rate for blacks is higher than for nonblacks in the São Paulo metropolitan area (see, for example, Lima, 2002), ethnic origin is, according Kilsztajn et al (2003), a confounding variable since there is an overrepresentation of blacks among poor, young males. This is similar to the situation in the United States, for example. However, this issue touches the larger problem of definition, namely, what is black and white in a country where nearly 40% of the total population call themselves *pardos* (or mixed).[3] However, geographical segregation of different ethnic groups in Brazil is not as marked as that found in the United States, nor is there the same link with differing degrees of violence depending on where people live (Krivo and Peterson, 1996; Kubrin and Weitzer, 2003; Sampson and Wilson, 1995).

Brazilian cities mirror the socioeconomic imbalances that exist within Brazilian society. Studies in Brazil corroborate the importance of social disorganisation risk factors as determinants of homicide rates (Camara et al, 2001; Cardia et al, 2003; Carneiro, 1998). The pioneer study of Carneiro (1998) provides evidence for such a relationship at the municipal level in the metropolitan areas of São Paulo and Rio de Janeiro in the 1980s and 1990s. Cardia et al (2003) summarise the underlying causes of high homicide rates as: competition for scarce resources; bureaucratic indifference; and the absence of responsible adults.

Although poverty levels are worse in Latin American cities than in many parts of the world,[4] it is not just poverty and social disorganisation that are of importance but also their geography. Contrary to North American city structure, where the pleasant living areas are mostly found in peripheral suburbs, in São Paulo slum areas are found in the periphery but also alongside luxury apartment buildings in districts away from the city core but still quite central. According to Caldeira (2000), up to the 1980s, the middle and upper classes were concentrated in the central neighbourhoods, whilst the most disadvantaged groups were on the periphery. From the 1980s on, a new urban structure has been superimposed. Different social groups are now closer to one another but separated by walls (for example, gated communities) and the technology of security. They rarely share common spaces. This contrasting socioeconomic patchwork found in more central areas of São Paulo is believed to generate very specific criminogenic conditions, both for property crimes and for violent crimes.

In many of these studies, there is a consensus that lethal violence cannot be satisfactorily explained by socioeconomic conditions alone. Social disorder and the use of violent methods as a means of conflict resolution (Black, 1984; Lee and Bankston, 1999)

[3] http://www.ibge.gov.br/.

[4] According to Hojman (2004), typically the ratio between incomes in a Western European country is about 5 or 6, but in Latin America this ratio is never less than 10 and in some cases may be as high as 30.

is a feature of some parts of São Paulo. Society is fragmented, deeply divided, and crossed through by so many diverging cultural identities, lifestyles, and consumption patterns that the solving of conflicts through institutional channels is often difficult (Adorno, 1996). The state is not only absent from many poor high-crime areas but also its presence can be ambiguous and arbitrary: it may be repressive (Lima, 2002). When state legal resources are inaccessible, people tend to take justice into their own hands or prefer to trust informal networks instead of formal institutions to solve their problems. When these networks include criminals, exchanges or favours become commonplace. In exchange for residents' silence and complicity, criminals provide a certain amount of protection—by providing weapons and by intimidation and fear. Such 'security' may periodically be disrupted by conflicts between the criminals and the police when the latter have been particularly repressive in poor areas (Caldeira, 2000).

Carneiro (1999) refers to the need to incorporate data on weapons availability and indicators that reflect the presence of gangs and drugs in order to explain homicide rates. The relationship between drug trafficking and homicides has been pointed out by several analyses in the Brazilian literature (for example, Lima, 2002; Zaluar, 2004). Zaluar (2004) characterises in detail how drug trafficking in Rio de Janeiro relates to levels of violence, drawing on cultural and structural factors. The combination of drugs and firearms explain the high mortality rate in the conflicts between youths for the control of drug sales points (Carneiro, 1998; Soares, 1996). In São Paulo this would mean that more central areas would also have high homicide rates, which is confirmed by Camara et al (2001). Lima's (2002) study of São Paulo, however, suggests a rather weaker link between drugs and homicides. Based on a sample of 4277 cases of homicides from 1995, Lima argues that the majority of homicides were associated with interpersonal conflicts that became lethal because of the widespread availability of firearms. Lima shows that the 'presence of drugs' was associated with only 2.3% of homicides for which the perpetrator was known, but with 34.2% of homicides for which the perpetrator was unknown (page 71). Lima suggests that the number of cases of homicide with any relation to drugs was inflated by the way these killings were dealt with by the police; however Lima has not made any estimate of how much lower these figures should be. Even if the figures are inflated, they provide clues about the nature of as much as one third of homicides for which the perpetrator was unknown. One of these clues could reinforce the link between drugs and lethal violence, since either victim or killer had some involvement with drugs—either as a user or as a trafficker (even though they did not possess drugs at the moment of the killing). Lima's findings therefore suggest that any attempt to reveal the dynamics between drugs and violence should go beyond the criterion 'presence of drugs' at the moment of the killing, since the deaths may be related to other activities related to drug trafficking, such as the marketing of illegal weapons or disputes between drug traffickers.

According to the United Nations (UN, 2003), illegal international groups have connections in Brazil for cocaine traffic, weapons trading, and money laundering—a business in which drugs are often exchanged for weapons. Both in São Paulo and Rio de Janeiro, violence is linked to drug consumption, and the power of criminal organisations and the conflicts between them to control drug distribution (UN, 2003, page 20). It is believed that drug trafficking employs more than 20 000 couriers (*aviõezinhos*), the majority of whom are adolescents, between 10 and 16 years of age, often coming from poor families. The chance of being arrested is small and traffickers have no difficulty in recruiting them to deliver drugs—a job that often leads to violence and death (UN, 2003). Although poverty and drug trafficking are closely linked in large urban areas in Brazil (Zaluar, 2004), their patterns may differ from city to city.

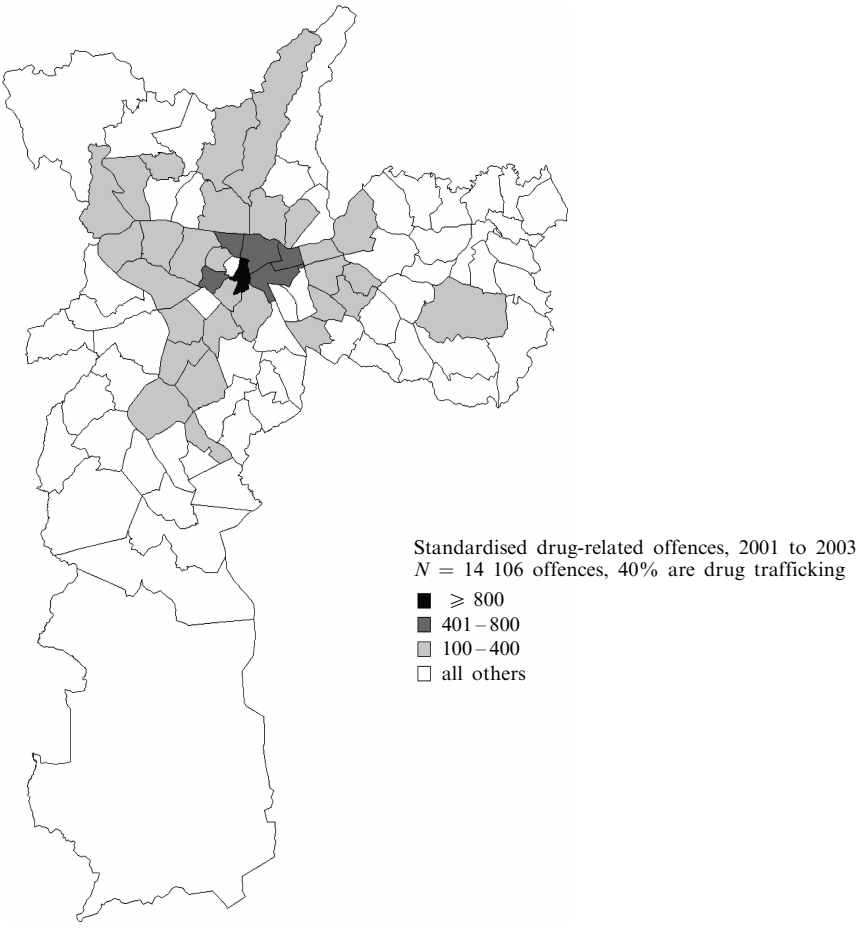


Figure 3. Areas with high relative risk for offences related to drugs (possession, use, or traffic) in São Paulo (source: Secretaria de Segurança Pública, 2004).

One reason for this differentiation is the fact that the cities have different drug trafficking 'structures'. Unlike Rio de Janeiro, where drug-selling points are concentrated in the hills and managed by a few 'drug barons', in São Paulo, the selling points seem to be widely scattered over the city and managed by hundreds of small traffickers, not only in poor neighbourhoods but also in central areas where many drug-selling points are concentrated (figure 3). The presence of drug trafficking results in an increase in cases of homicide, particularly in more central areas with no slums, according to the analysis of 1332 census sectors of São Paulo undertaken by Kahn and Zanetic (2005). Figure 3 shows the concentrated pattern of drug-related offences in São Paulo with standardisation by resident population. As many as 60% of these offences are related to drug possession and use. As many as 42% of all police calls in São Paulo in 2001/03 were related to drug trafficking. This is corroborated by data from the last victimisation survey (GSI/ILANUD/FIA-USP, 2002), in which drug trafficking and poverty are cited as the main causes of criminality in São Paulo.

4.2 A conceptual model for intraurban variation in homicide rates in São Paulo

We distinguish two groups of factors that affect the geography of homicides in São Paulo (figure 4). The first comprise the political, institutional, economic, and cultural characteristics of a society. These *contextual* factors mostly affect the level of different

types of offences, including homicide (La Free, 1999; Lee and Bankston, 1999; Messner, 2003). However, these societal characteristics may interact locally and thus have an impact on the geography of certain offences (see, for example, Abramovay et al, 2002). For example, where national economic policy leads to higher levels of unemployment, this may lead to higher levels of certain types of economically motivated crime, and these are likely to occur disproportionately in certain neighbourhoods. The second group of factors include those that directly affect the *geography* of homicide within an urban area because they vary at that scale (figure 4). Although we recognise the importance of contextual factors, it is only possible here to test at the intraurban level factors which have a direct impact on the geographical distribution of homicides. The implication is, however, that these patterns may not be stable over time but, rather, depend on (external) contextual influences.

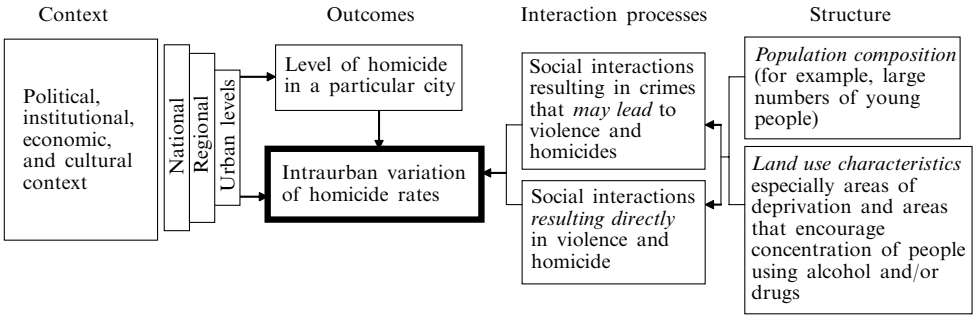


Figure 4. The intraurban geography of homicide: a conceptual framework.

(1) *Spatial variation in homicide rates is linked to the geography of long-term poverty*
Homicides in São Paulo are expected to be concentrated in certain parts of the city, particularly in poor neighbourhoods. Favelas are the dwelling places of the poor, built on plots without landownership rights. These unplanned settlements often lack basic infrastructure and are densely occupied. Poverty and long-term deprivation can be seen as forces that both 'release people to engage in violence', since there is no social control to impede them, and 'push people into violence' (Messner and Rosenfeld, 1999). If social bonds and social control are weak, people resolve conflict through violence. Poverty may breed frustration that spills over into violence. Deprived of economic resources, this may lead some to engage in various criminal acts that may have violent outcomes.

(2) *Spatial variation in homicide rates is linked to particular patterns of human activity and routine activities which are in turn linked to urban land-use structure and the composition of the resident or transient population in these areas*
Based on routine activity and opportunity perspectives, the distribution of homicides might be a function of the convergence in time and space of motivated offenders and suitable targets in the absence of capable guardians (Cohen and Felson, 1979; for application of this approach to research into homicides, see Gartner, 1990). We identify three sources of lethal violence. The first activity pattern refers to the dynamics that characterise São Paulo's core as a global city (Sassen, 1991). Here, there is competition for space between activities that attract very different social groups. For example, exclusive city-centre restaurants are located near inner-city transport nodes, bars, bingo halls, prostitution houses ('saunas'), low-price stores, and deteriorating residential areas. Such places often concentrate large numbers of people during the whole day. This generates particular criminogenic conditions that may result in violent crime.

These places may concentrate people who consume alcohol and/or drugs, which trigger conflicts that would not occur otherwise. They also provide social interactions that generate individual violence and criminal disputes that may spread from place to place (Cohen and Tita, 1999), dependent on the level of police vigilance and intervention.

The second pattern relates to the establishment of shopping areas, entertainment centres, and retailers, often close to transport nodes such as underground and bus stations. Although these areas are often the targets of those involved in property crimes, many robberies directed at individuals end in violence. Such violence is often clustered in space close to such regional centres and spills over into nearby areas. These other areas have high levels of violence not so much because of their own characteristics but, rather, because of their geographic proximity to such areas.

(3) *Areas with high levels of homicide are characterised by criminogenic conditions that reveal a symbiosis with other crimes.*

In the case of São Paulo, this is particularly the case with drug-related offences and the availability of firearms. According to the United Nations (UN, 2003, page 20) both in São Paulo and Rio de Janeiro high levels of violence are linked to the expansion of youth drug consumption, the increased power of criminal organisations, and the rise in conflicts between these organisations as they seek to control drug-distribution points (UN, 2003). Although the literature in the past suggested a weak link between drug trafficking and homicides (for example, Lima, 2002), we argue that in São Paulo the symbiosis of drug-related offences and violence takes place at two levels. One level concerns conditions and or social interactions, that are provided by typical drug markets: they are localised and their location is determined by certain land-use types as pointed out in (2). These areas are mostly related to sites of consumption of drugs (Cardia and Schiffer, 2000). It is expected that in these sites the deaths are genuinely related to drug use and trafficking. The second level concerns the impact of criminal groups related to drug trafficking in poor neighbourhoods. For instance, young males recruited into the drugs trade are armed for self-protection and status (Blumstein, 1995; Cohen and Tita, 1999; Kilsztajn et al, 2002). Later these guns spread into the wider community, generating conditions for many different forms of serious crime. Weapons were presented at the moment of crime in São Paulo in 70% of cases of robbery and 42% of cases of physical aggression according to the last victimisation survey (GSI/ILANUD/FIA-USP, 2002); firearms were responsible for 88% of all cases of homicide in Brazil in 1996 (Kahn, 2005).

Figure 4 provides a representation of this conceptual framework. Note that the model expresses homicide outcomes as the end product of a local process that is based on the structural backcloth of the city (in terms of poverty and land use) which, in turn, generates certain types of social interactions that lead to homicide. Homicide outcomes are also shown as a consequence of larger scale, contextual factors. Although not explicitly shown in figure 4, these contextual factors are likely to have some impact on local structures and local processes of social interaction.

5 Empirical analysis

5.1 Standardised homicide ratios

For each of the ninety-three police districts of São Paulo (figure 2), a standardised homicide ratio (SHR) was calculated for *homicidio doloso* from July 2001 to June 2002. Standardisation is a useful way of representing data for a set of areas where the areas differ in size (absolute values would tend to overemphasise large areal units) and where it is necessary to allow for differences in population characteristics between areas

(Haining, 2003). For other examples of standardised offence ratios, see Ceccato et al, 2002. The SHR for district i is given by:

$$\mathrm{SHR}_i = 100\left(\frac{O_i}{E_i}\right), \quad (1)$$

where O_i is the observed number of cases of homicide and E_i is the expected number of cases of homicide. In this analysis, an average homicide rate for São Paulo was obtained by dividing the total number of offences by the total size of the chosen denominator. For each district i, this average rate was multiplied by the size of the chosen denominator in district i to yield E_i.[5] Because homicide levels are highly correlated with the proportion of young people in São Paulo (Lima, 2002), the total male population aged between 10 and 20 years was used as the denominator for the homicide rates. (The presence of this variable as an independent variable might overwhelm the influence of other, more interesting, covariates.) Figure 2 shows the map of relative risk for homicide in São Paulo, identifying all areas where $O_i > E_i$. These rates may overestimate the risk of being a homicide victim in an area since the denominator data on the young male population does not include visitors.[6]

There are two distinct types of areas with high standardised homicide ratios in São Paulo. The first are central areas that are highly vulnerable to acts of lethal violence: Sé, Pari, Brás e Campos Elíseos, including the so-called *centro velho*—the old central business district (CBD) (figure 2). The old CBD is located in the core of the inner city and is characterised by office buildings, hotels, restaurants, cinemas, and hospitals—places that concentrate many people during the whole day. These areas have or are located near to transport nodes and also contain bars, bingo houses, prostitution houses, and run-down neighbourhoods. According to police records, they are home to most of the São Paulo drugs market (figure 3). The second are residential areas located on the periphery. These are mainly disadvantaged areas with a high proportion of low-income households, lacking basic infrastructure, with a high proportion of young people (aged 10 to 25 years), and with high rates of adult illiteracy. Examples are Capão Redondo, Jardim Herculano, Jaçanã, Parque São Rafael, São Matheus, Vila Jacuí, Jardim dos Ipês (figure 2).

5.2 Modelling standardised homicide ratios

In this section we report the results of modelling the geography of homicide using socioeconomic variables and other offences as covariates (appendix A). The purpose is to explain the variation in area-specific or relative risk of homicide in São Paulo.

Nine variables were used, deriving from the conceptual framework described in section 4.2. The list of independent variables to be tested in the model encompasses some of the key correlates of neighbourhood homicide rates in the literature (see section 3). The three distinct dimensions tested were:

(1) Poverty as an indicator of absolute and relative deprivation and exclusion has been long associated with high homicide rates (for extensive reviews, see Carneiro, 1999; Heitmeyer and Hagan, 2003; Smith and Zahn, 1999). We include 'head of household with no income' (X_3) and 'favelas' (X_4) as measures of poverty.

(2) In order to take situational effects into consideration, land-use variables were included (see Gartner, 1990). Patterns of human activity are influenced by land use.

[5] E_i can be thought of as the number of homicides that would occur in area i if homicides were occurring randomly across São Paulo as a function of the chosen denominator.

[6] In an earlier model we examined for the significance of population density, both because of the choice of the denominator and also because areas of low population density might be sites where killings took place or bodies were dumped. Population density was not significant at the 5% level.

We include the locations of bars (X_8), transport nodes (X_7), and the location of the city centre (X_6). This last is included as a dummy variable: if the ith area is part of the inner city then $D_i = 1$; otherwise $D_i = 0$. This was created as the city centre has a mixture of land use and attracts very different social groups. The other land-use variables identify areas where population converges. These might generate particular criminogenic conditions for violent crime.

(3) We argue that, in São Paulo, the symbiosis of certain criminogenic conditions generated by certain crimes (for example, drug-related offences, availability of weapons) will affect levels of violence (see, for example, Blumstein, 1995; Cohen and Tita, 1999; Goldstein, 1985; Kilsztajn et al, 2002). We include, therefore, drug-related offences (X_1) and the availability of weapons on the streets (X_2).

Ethnic background has not been included as a covariate in the models. Although homicide rates are high amongst the young black population (Lima, 2002), there is an overrepresentation of blacks among poor, young, males (Kilsztajn et al, 2003). This makes it difficult to separate the ethnic dimension from the poverty dimension, and for reasons given in section 4 the poverty dimension is believed to be the more important in the context of São Paulo. The proportion of individuals with long-term alcohol problems (X_5) was also added in the regression model as the literature suggests it has an effect on homicide levels (see, for example, Fagan, 1990; Parker, 1993). Alcohol decreases the individual's cognitive capacity and at the same time it increases the individual's likelihood of reacting aggressively when provoked (Exum, 2002).

Three independent variables (X_1, X_2, and X_3) were also included as spatial averages denoted W_X. The effect of the level of some independent variables might extend beyond the census district where that level was recorded, and we tested for these effects. Another reason for creating these lagged predictor variables was to counter the limitations imposed by unit boundaries on the analysis. To calculate a spatial average, the values for each area and its adjacent neighbours were averaged (Haining, 2003, page 82).

The full set of independent variables (and lagged forms) was included in the model. Initially, the linear regression model was fitted by ordinary least squares (OLS) in order to test the statistical significance of covariates in explaining the variation in SHR. The set of SHR values show a highly skewed distribution. The raw SHR data were transformed using the square-root transformation to produce a dataset more nearly normally distributed. The regression analysis was implemented in GeoDa (Anselin, 2005) since this software has regression-modelling capabilities that are appropriate for spatial analysis. GeoDa provides several statistics measuring the fit of the model, and includes diagnostic tests, such as tests for multicollinearity among independent variables and tests on model errors (normality, heteroskedasticity, and spatial autocorrelation). In order to test for spatial autocorrelation in the errors (in practice, the residuals), the binary weight matrix based on shared common boundaries was used to represent the spatial arrangement of the census tracts.

5.3 Model results

We decided to run two models. The correlation between the two covariates 'availability of weapons' and 'drug-related offences' (standardised ratios) was 0.79 and significant at the 0.01 level. These are highly correlated and have similar geographies. Including them both in the same model means that we would not be able to distinguish between them. It was decided therefore to test for them separately and to assess the overall impact of their inclusion or exclusion on model results. So, in the first set of models all covariates except 'availability of weapons' were included whereas in the second set we included

Table 1. Modelling standardised homicide ratios: significant variables using two sets of models.

Models with drug-related offences		Models with availability of weapons	
OLS	lag	OLS	lag
X_1	X_1		
		X_2	X_2
X_3	X_3		X_3
$W\_X_3^*$	$W\_X_3^*$	$W\_X_3^*$	$W\_X_3^*$
X_4	X_4	X_4	X_4
X_5	X_5	X_5	X_5
X_7	X_7	X_7	X_7
X_9	X_9		
	W_Y		
R^2(%) 70.3	72.5	69.9	75.2

Note. OLS—ordinary least squares.

all covariates except 'drug-related offences'. Table 1 summarises the significant variables from both models.

5.3.1 *Models including the covariate 'drug-related offences' and excluding 'availability of weapons'*

The OLS model shows that households with no income (X_3), its lagged form ($W\_X_3^*$), favelas (X_4), drug-related offences (X_1), individuals with alcohol problems (X_5), transport nodes (X_7), and betting houses (X_9) were statistically significant in explaining the pattern of relative risk of homicide in São Paulo. The OLS model explains 70.3% of variation in the SHRs. Diagnostic checks show that the errors are normal and homoskedastic and that there is no problem with multicollinearity (condition value < 20). Moran's I test and the Lagrange multiplier tests provide evidence of spatial autocorrelation in the residuals. If this problem is ignored, the model may lead to false indications of significance, biased parameter estimates, and a misleading measure of fit (Messner and Anselin, 2004). A common remedial practice is either to find new covariates to include in the model, or to fit a spatial lag model or a spatial error model. The first option is not feasible in this case. The spatial lag model includes a lagged form of the response variable (SHR) as one of the independent variables. There are three remarks to make arising from fitting the OLS and the two spatial regression models: (i) the spatial lag model appears to provide the best fit ($R^2 = 72.5$); (ii) there is no evidence of spatial autocorrelation in the residuals of either of the two spatial regression models, and (iii) the models share seven covariates that are statistically significant (figure 5).

5.3.2 *Models including the covariate 'availability of weapons' and excluding 'drug-related offences'*

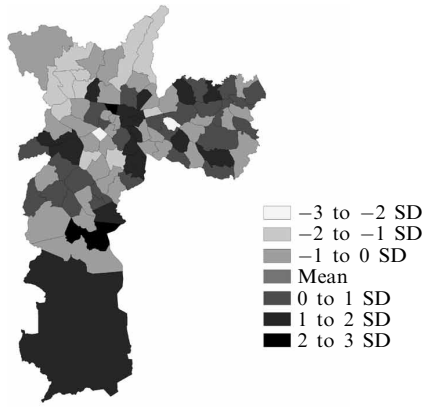
A smaller set of variables were significant in this OLS model compared with the first model. Availability of weapons (X_2), favelas (X_4), head of household with no income in its lagged form ($W\_X_3^*$), transport nodes (X_7), and individuals with long-term alcohol problems (X_5) were significant and explained 69.9% of the variation in the SHRs. As in the previous model, the assumption of no residual spatial autocorrelation was violated (both Moran's I and the Lagrange multiplier tests on residuals were significant) so we ran the spatial lag model. As much as 75.2% of the variation in the SHRs was now explained by the variables of the spatial lag model. Spatial autocorrelation in the residuals was no longer a problem (figure 6).

$$1.19 + 17.13X_3^{***} + 46.13X_4^{***} + 34.23W\_X_3^{***} + 0.004X_1^{**} + 58.94X_7^{***} + 12.45X_5^{**} + 20.41X_9^{**}$$
(1.51) (3.86) (5.82) (4.77) (2.48) (3.99) (2.11) (2.08)

(t-values in parentheses)

** significant at 5% level
*** significant at 1% level

$R^2 \times 100 = 70.29$
$R^2 \times 100$ (adjusted) = 67.85
Normality of errors Jarque–Bera 0.07 probability 0.96
Multicollinearity condition number 13.02
Heteroskedasticity—Breuch–Pagan 4.43 probability 0.72
Moran's I (error) 3.08, probability 0.00
Lagrange multiplier (error) 6.28, probability 0.01
Lagrange multiplier (lag) 9.55, probability 0.00



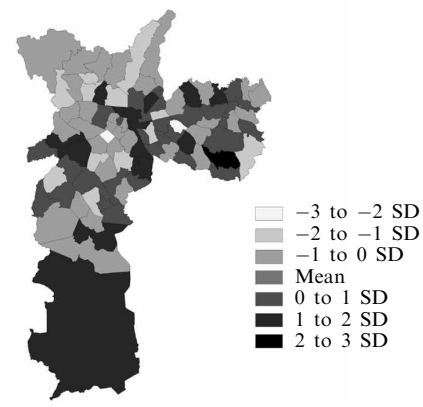
(a) Ordinary least square estimation, Y = square root of standardised homicide rates.

$$-0.49 + 0.36W\_Y^{***} + 13.74X_3^{***} + 37.58X_4^{***} + 25.42W\_X_3^{***} + 0.003X_1^{**} + 52.49X_7^{***} + 12.77X_5^{**} + 17.53X_9^{**}$$
(−0.58) (3.72) (3.39) (4.93) (3.78) (1.98) (3.95) (2.43) (2.01)

(z-values in parentheses)

** significant at 5% level
*** significant at 1% level

$R^2 \times 100 = 72.54$
Heteroskedasticity—Breuch–Pagan 5.42 probability 0.63
Lagrange multiplier (error) 0.08, probability 0.077



(b) Lagged response model: maximum-likelihood estimation, Y = square root of standardised homicide rates.

Figure 5. Results of the models with 'drug-related offences' with diagnostics.

The predictors that are significant both in the OLS and in the lagged response models in the two sets of models are: spatially averaged value for the proportion of heads of household with no income ($W\_X_3^*$), favelas (X_4), individuals with long-term alcohol problems (X_5), and transport nodes per unit area (X_7) (table 1).

5.4 Discussion of the results

The results suggest the existence of several independent dimensions that explain the spatial variation in homicide rates at the small area level in São Paulo after controlling the size of the 10–20-year-old male population in these areas.[7] The first dimension is strongly linked to poverty (X_3, X_4). In all models, the signs of the regression coefficients

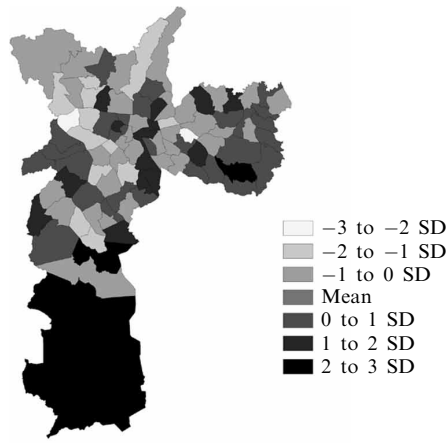
[7] In a Poisson regression analysis of this data, this would be equivalent to treating the size of the 10–20-year-old male population in each area as an offset variable. Poisson regression has not been used in this analysis because of the problems of dealing with spatial autocorrelation effects in Poisson regression.

$$2.44 + 39.77X_4^{***} + 31.25W\_X_3^{***} + 0.02X_2^{***} + 38.89X_7^{***} + 15.09X_5^{**}$$
(3.47) (5.31) (4.49) (7.00) (2.58)

(t-values in parentheses)

** significant at 5% level
*** significant at 1% level

$R^2 \times 100 = 69.91$
$R^2 \times 100$ (adjusted) $= 68.81$
Normality of errors Jarque–Bera 0.20 probability 0.90
Multicollinearity condition number 11.13
Heteroskedasticity—Breuch–Pagan 1.2 probability 0.86
Moran's I (error) 2.36, probability 0.02
Lagrange multiplier (error) 3.38, probability 0.07
Lagrange multiplier (lag) 11.69, probability 0.00



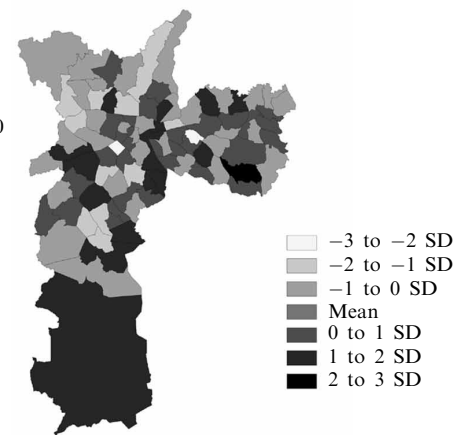
(a) Ordinary least square estimation, Y = square root of standardised homicide rates.

$$0.04 + 0.34W\_Y^{***} + 10.58X_3^{***} + 28.08X_4^{***} + 19.31W\_X_3^{***} + 0.014X_2^{**} + 37.95X_7^{***} + 12.47X_5^{**}$$
(0.05) (3.59) (2.84) (4.08) (3.01) (6.40) (2.93) (2.93)

(z-values in parentheses)

** significant at 5% level
*** significant at 1% level

$R^2 \times 100 = 75.25$
Heteroskedasticity—Breuch–Pagan 5.39 probability 0.40
Lagrange multiplier (error) 0.002, probability 0.95



(b) Lagged response model: maximum-likelihood estimation, Y = square root of standardised homicide rates.

Figure 6. Results of the models with 'availability of weapons' with diagnostics.

are positive—as they should be. In São Paulo, these types of area are found in the most peripheral areas where there are large proportions of low-income households as well as a high proportion of young males.

The second dimension appears to be linked to situational factors that have the propensity to create criminogenic conditions which may lead to violence. Homicide rates are high where transport nodes are located (for example, bus, underground, and railway stations). These areas often have other facilities that concentrate large numbers of people during the whole day, so it is not necessarily the transport nodes themselves that are the catalysts. However, these areas are likely to generate particular criminogenic conditions for violent crime of at least two types. One type concerns a form of lethal violence that is a result of personal conflicts in areas that concentrate people

who may have consumed alcohol and/or drugs. A second type of homicide in these areas may have an economic motivation. Now, data on robbery followed by death are supposedly excluded from the database used here but, for reasons discussed in section 2, it is impossible to be sure that some cases of this form of homicide are not included. In order to investigate this argument further, we compared the patterns of 'standardised robbery followed by death' ratios with the SHRs (figure 2). Robbery followed by death has an inner-city pattern that often follows the transport network. When 'standardised robbery followed by death' ratios were modelled using the same set of independent variables, the number of transport nodes per unit area is the only significant variable and explains 22% of the variation in this form of homicide.

The third dimension captures the link between homicides and criminogenic conditions generated by the availability of weapons or drug-related activity. As noted, the two covariates have such similar patterns of geographic variation that it is impossible to disentangle their contribution. What can be said, however, is that at the small area population level, both the availability of weapons and the presence of drug-related offences do have an impact on homicide rates.

The fourth and final dimension is that there is some evidence of a spillover effect in homicides. Areas with high homicide ratios are found adjacent to other areas with high homicide ratios. This effect is over and above that which might be expected from the continuity of those covariates that act as predictors of lethal violence—at least those that have been included in the model. There is some evidence from this analysis that 'violence begets violence', in the sense of a spatially contagious (adjacent neighbourhoods) process.

In the context of the regression modelling used here, these predictors are independent but, of course, additive. Areas with the highest homicide ratios will be those areas where high levels of all these different factors come together. One might argue from these modelling results that those areas of São Paulo characterised by the most extreme levels of poverty, where young males concentrate, and where there is the potential for high levels of social interaction energised by alcohol and drugs (both taking and trafficking), and where weapons are available, are the areas that will experience the highest levels of homicide—particularly if these areas are near to other areas where homicides are frequent. Of course, such a picture cuts through some of the more complex arguments reviewed earlier in the paper, but the levels of explanation achieved by all the models are high. The sheer number of homicides in a city the size of São Paulo may be what underlies such a finding.

6 Directions for future research

The case for São Paulo illustrates how a simple descriptive model performs rather well in explaining variation in homicides at the small area level when compared with existing evidence from Europe and the USA. Geographical variation in standardisation homicide ratios (controlling for the number of young males in the age cohort 10–20 years) has been shown to be related to areas of poverty, areas where people concentrate—perhaps for leisure and entertainment, and areas where drug-related offences are high and/or where firearms are available. In any future aggregate scale analysis, the incorporation of other types of indicators beyond the ones used in this study might help to establish more clearly the connection between the characteristics of each district and lethal violence. However, if the purpose is to develop mechanistic models (that is, models that focus on the criminogenic mechanisms rather than the structural characteristics of areas) then measures of collective efficacy (Morenoff and Sampson, 1997) could, for instance, be incorporated in the analysis as an indicator of the social control and trust in local institutions in an area. On the one hand, on the strength of

the findings here we have to question whether the inclusion of such subtle ecological factors is really going to improve our current descriptive model significantly. On the other hand, a focus on ecological factors is perhaps a basis for constructing other types of models.

Whilst these results shed light on the problem for small area populations, more detailed understanding requires close analysis of individual cases whilst continuing to recognise the importance of ecological or neighbourhood factors. Unfortunately, the police database does not include data about the victims or events and cannot be linked to the IML database. In these circumstances it is not possible to analyse down to the level of individual events and circumstances. If individual-level data were available, an important question would be to assess to what extent drug-related offences interact with weapons. It is believed that São Paulo differs from Rio de Janeiro in its geography and organisation of drug trafficking (for example, drugs-selling points) but little is known about how this affects the number of violent encounters that become lethal.

Analyses of the spatial dimension of intraurban patterns of homicides contribute to a better understanding of the phenomenon. Certain places provide social interactions and patterns of behaviour that lead to extreme forms of violence. There is some evidence of spillover effects in the sense that the act of violence may take place some short distance from the criminogenic origin. Future research should include detailed investigation into the nature of these processes. There is a need to investigate the nature of social networks involving violence at the individual level, whether or not they go beyond local 'neighbourhood' boundaries. This might shed light on cases of multiple murders, which is also an underresearched area. Evidence is needed about the distribution of homicides across neighbourhoods in the city over time, particularly in relation to the offenders, the victims, and the situational context within which they meet.

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References

Abramovay M, Castro M G, Pinheiro L C, Lima F S, Martinelli C C, 2002 *Juventude, Violência e Vulnerabilidade Social na América Latina: Desafios para Políticas Públicas* UNESCO/BID, Brasília

Adorno S, 1996 *A Gestao Urbana do Medo e da Inseguranca: Violencia, Crime e Justica Penal na Sociedade Brasilieira Contemporanea* Tese de livre docenia, Faculdade de Filosofia, Letras e Ciencias Humanas, Universidade de São Paulo, São Paulo

Anselin L,2005 *Exploring Spatial Data with GeoDaTM: A Workbook* Department of Geography, University of Illinois, Urbana-Champaign, Urbana, http://sal.uiuc.edu/

Baumer E, Lauritsen J L, Rosenfled R, Wright R, 1998, "The influence of crack cocaine on robbery, burglary, and homicide rates: a cross-city, longitudinal analysis" *Journal of Research in Crime and Delinquency* **35** 316 – 340

Black D, 1984, "Social control as a dependent variable", in *Toward a General Theory of Social Control* Ed. D Black (Academic Press, Orlando, FL) pp 1 – 26

Blau J R, Blau M P, 1982, "The cost of inequality: metropolitan structure and criminal violence" *American Sociological Review* **47** 114 – 129

Blumstein A, 1995, "Violence by young people: why the deadly nexus?" *National Institute of Justice* **229** 2 – 8, http://www.ncjrs.org/pdffiles/nijj_229.pdf

Bromley R D F, Nelson A L, 2002, 'Alcohol-related crime and disorder across urban space and time: evidence from a British city" *Geoforum* **33** 239 – 254

Brownstein H H, Baxi H, Goldstein P, Ryan P, 1992, "The relationships of drugs, drug trafficking and drug traffickers to homicide" *Journal of Crime and Justice* **15** 25 – 44

Burton J R, Cullen F T, Evans T D, Dunaway R G, 1994, "Reconsidering strain theory: operationalization, rival theories and adult criminality" *Journal of Quantitative Criminology* **35** 213 – 239

Buvinic M, Morrison A, Shifter M, 1999 *Violence in Latin America and the Caribbean: A Framework for Action* Sustainable Development Department, Inter-American Development Bank, http://www.iadb.org/sds/doc/1073eng.pdf

Caldeira T P R, 2000 *City of Walls: Crime, Segregation and Citizenship in São Paulo* (University of California Press, Berkeley, CA)

Camara G, Monteiro A M, Ramos F R, Sposati A, Roga D, 2001 *Mapping Social Exclusion/ Inclusion in Developing Countries* draft version, http://www.dpi.inpe.br/gilberto/papers/Sãopaulo_csiss.pdf

Cardia N, Schiffer S, 2000 *São Paulo Secondary Data Analysis* (World Health Organisation, Substance Abuse Division, Geneva); http://www.nev.prp.usp.br/NEV_Arquivos/publica/sp1s.pdf

Cardia N, Adorno S, Poleto F Z, 2003, "Homicide rates and human rights violations in São Paulo, Brazil: 1990 – 2002" *Health and Human Rights* **6** 15 – 33

Carneiro L P, 1998, "Firearms in Rio de Janeiro: culture, prevalence and control", in *Connecting Weapons with Violence: The South American Experience* http://www.iss.co.za/Pubs/Monographs/No25/Contents.html

Carneiro L P, 1999 *Determinantes do crime na America Latina: Rio de Janeiro e São Paulo* research report, Universidade de São Paulo, São Paulo

Ceccato V, 2005, "Homicide in São Paulo, Brazil: assessing spatial – temporal and weather variations" *Journal of Environmental Psychology* **25** 249 – 360

Ceccato V, Haining R, Signoretta P, 2002, "Exploring crime statistics in Stockholm using spatial analysis tools" *Annals of the Association of American Geographers* **22** 29 – 51

Chevigny P, 1999, "Defining the role of the police in Latina America", in *The (Un)rule of Law and the Underprivileged in Latin America* Eds J Mendez, G O'Donell, P S Pinheiro (Notre Dame University Press, Notre Dame) pp 49 – 70

Chevigny P, 2003, "The populism of fear: politics of crime in the Americas" *Punishment and Society* **5** 77 – 96

Cohen J, Tita G, 1999, "Diffusion in homicide: exploring a general method for detecting spatial diffusion process" *Journal of Quantitative Criminology* **15** 451 – 493

Cohen L E, Felson M, 1979, "Social change and crime rate trends: a routine activity approach" *American Sociological Review* **44** 588 – 608

Corzine J, Corzine L H, Whitt H P, 1999, "Cultural and subcultural theories of homicide", in *Homicide: A Sourcebook of Social Research* Eds M D Smith, M A Zahn (Sage, London) pp 42 – 58

Craglia M, Haining R P, Signoretta P, 2001, "Modelling high intensity crime areas in English cities" *Urban Studies* **38** 1921 – 1941

Craglia M, Haining R P, Signoretta P, 2005, "Modelling high-intensity crime areas: comparing police perceptions with offence/offender data in Sheffield" *Environment and Planning A* **37** 503 – 524

Exum M L, 2002, "The application and robustness of the rational choice perspective in the study of intoxicated and angry intentions to aggress" *Criminology* **40** 933 – 966

Fagan J, 1990, "Intoxication and aggression", in *Crime and Justice: A Review of Research* volume 13, Eds M Tonry, J Q Wilson (University of Chicago Press, IL) pp 241 – 320

Farrington D, Loeber R, Southamer-Loeber M, 2003, "How can the relationship between race and violence be explained?", in *Violent Crime: Assessing Race and Ethnic Differences* Ed. D F Hawkins (Cambridge University Press, Cambridge) pp 213 – 237

Felson R B, 1993, "Predatory and dispute-related violence: a social interactionist approach", in *Routine Activity and Rational Choice* Eds R V Clarke, M Felson (Transaction Books, New Brunswick, NJ) pp 103 – 123

Felson R, Messner S F, 1996, "To kill or not to kill? Lethal outcomes in injurious attacks" *Criminology* **34** 519 – 545

Fox J A, Piquero A R, 2003, "Deadly demographics: population characteristics and forecasting homicide trends" *Crime and Delinquency* **49** 339 – 359

Gartner R, 1990, "The victims of homicide: a temporal and cross sectional comparison" *American Sociological Review* **55** 92 – 106

Gawryszewski V P, Kahn T, Jorge M, 2004 *Homicidios no Municipio de São Paulo: Integrando Informaçoes para Ampliar o Conhecimento do Problema* (Secretaria de Estado da Segurança Pública, São Paulo)

Goldstein J C, 1985, "The drugs – violence nexus: a tripartite conceptual framework" *Journal of Drug Issues* **14** 493 – 506
Goldstein J C, Brownstein H H, Ryan P J, Bellucci P A, 1989, "Crack and homicide in New York City, 1988: a conceptually based event analysis" *Contemporary Drug Problems* **16** 651 – 687
GSI/ILANUD/FIA-USP, 2002 *Pesquisa de Victimização 2002 e Availiação do PIAPS* (GSI/ILANUD/FIA-USP, São Paulo)
Haining R, 2003 *Spatial Data Analysis: Theory and Practice* (Cambridge University Press, Cambridge)
Heitmeyer W, Hagan J (Eds), 2003 *International Handbook of Violence Research* (Kluwer, Dordrecht)
Hojman D, 2004, "Inequality, unemployment and crime in Latin American cities" *Crime, Law and Social Change* **41** 33 – 51
IBGE, 2004 *Cadastro de Unidades Domiciliaries* Instituto Brasileiro de Geografia e Estatística, http://www.ibge.gov.br
Inter-American Development Bank, 2000 *Development Beyond Economics: Economic and Social Progress in Latin America—2000 Report* (Johns Hopkins University Press, Baltimore, MD)
Kahn T, 2005, "Armas de fogo: argumentos para o debate", lecture notes, Secretaria de Segurança Pública de São Paulo, São Paulo
Kahn T, Zanetic A, 2005, "O papel dos municipios na seguranca publica" working paper, Centre for Brazilian Studies, University of Oxford, Oxford, forthcoming
Kilsztajn S, Rossbach A, Carmo N, Sugahara L, Souza L B, 2002 *Vítimas Fatais da Violência e Mercados de Drogas na Região Metropolitana de São Paulo* (LES/PUCSP, São Paulo)
Kilsztajn S, Carmo N, Sugahara L, Lopes E S, 2003 *Vítimas da Cor—Homicídios na Região Metropolitana de São Paulo, 2000* (LES/PUCSP, São Paulo)
Kornhauser R, 1978 *Social Sources of Delinquency* (University of Chicago Press, Chicago, IL)
Krivo L J, Peterson R D, 1996, "Extremely disadvantaged neighborhoods and urban crime" *Social Forces* **75** 619 – 650
Kubrin C E, 2003, "Structural covariates of homicide rates: does type of homicide matter?" *Journal of Research in Crime and Delinquency* **40** 139 – 170
Kubrin C E, Weitzer R, 2003, "Retaliatory homicide: concentrated disadvantage and neighborhood culture" *Social Problems* **50** 157 – 180
La Free G, 1999, "A summary and review of cross-national comparative studies of homicide", in *Homicide: A Sourcebook of Social Research* Eds M D Smith, M A Zahn (Sage, London) pp 125 – 145
Lee M R, Bankston W B, 1999, "Political structure, economic inequality and homicide: a cross-sectional analysis" *Deviant Behaviour: An Interdisciplinary Journal* **19** 27 – 55
Lima R S, 2002 *Conflitos Sociais e Criminalidade Urbana: Uma Analise dos Homicidios Cometidos no Municipio de São Paulo* (Sicurezza, São Paulo)
Mercer Human Resources,2004 *Quality of Living Report,* http://www.mercerhr.com/
Messner S, 2003, "Understanding cross sectional variation in criminal violence", in *International Handbook of Violence Research* Eds W Heitmeyer, J Hagan (Kluwer, Dordrecht) pp 701 – 718
Messner S, Anselin L, 2004, "Spatial analysis of homicide with areal data", in *Spatially Integrated Social Science* Eds M Godchild, D Janelle (Oxford University Press, Oxford) pp 127 – 144
Messner S, Rosenfeld R, 1999, "Social structure and homicide: theory and research", in *Homicide: A Sourcebook of Social Research* Eds M D Smith, M A Zahn (Sage, London) pp 27 – 41
Miethe T D, Drass K A, 1999, "Exploring the social context of instrumental and expressive homicides: an application of qualitative analysis" *Journal of Quantitative Criminology* **15** 1 – 21
Morenoff J D, Sampson R, 1997, "Violent crime and the spatial dynamics of neighbourhood transition: Chicago, 1970 – 1990" *Social Forces* **76** 31 – 64
Parker R N, 1993, "Alcohol and theories of homicide", in *Advances in Criminological Theory* Eds F Adler, W Laufer (Transaction Books, New Brunswick, NJ) pp 113 – 142
Parker R N, Smith M D, 1979, "Deterrence, poverty and type of homicide" *American Journal of Sociology* **85** 614 – 624
Rolnik R, 2001, "Territorial exclusion and violence: the case of the state of São Paulo Brazil" *Geoforum* **32** 471 – 482
Rossow I, 2001, "Alcohol and homicide: a cross-cultural comparison of the relationship in 14 European countries" *Addiction* **1** 77 – 92
Sampson R J, Wilson W J, 1995, "Toward a theory of race, crime and urban inequality", in *Crime and Inequality* Eds J Hagan, R D Peterson (Stanford University Press, Stanford, CA) pp 37 – 57

Sassen S, 1991 *The Global City: New York, London, Tokyo* (Princeton University Press, Princeton, NJ)
Shaw C R, McKay H D, 1942 *Juvenile Delinquency and Urban Areas* (University of Chicago Press, Chicago, IL)
Smith M D, Zahn M A (Eds), 1999 *Homicide: A Sourcebook of Social Research* (Sage, London)
Soares L E, 1996, "Mapeamento da criminalidade letal", in *Violência e Política no Rio de Janeiro* Ed. L E Soares (Relume Dumará e ISER, Rio de Janeiro) pp 237
UN, 2003 *Country Profile: Brazil* United Nations, http://www.unodc.org/pdf/brazil/brazil_country_profile.pdf
Wikström P H, 1991 *Urban Crime, Criminals, and Victims: The Swedish Experience in an Anglo-American Comparative Perspective* (Springer, Berlin)
Wilson W J, 1987 *The Truly Disadvantaged: The Inner City, the Underclass and the Public Policy* (University of Chicago Press, Chicago, IL)
Wolfgang M E, Ferracuti F, 1967 *The Subculture of Violence* (Tavistock, London)
Yunes J, Zubarew T, 1999, "Mortalidad por causas violentas en adolescentes y jovenes: un desafío para la region de las Americas" *Revista Brasileira de Epidemiologia* **3** 102 – 171
Zaluar A, 2004 *Integração perversa: pobreza e tráfico de drogas* (Editora Fundaçao Getúlio Vargas, Rio de Janeiro)

Table A1. Characteristics of the dataset.

Type of data	Description	Year	Source
Offences	*Homicide by coordinates and district—standardised homicide ratios* (Y) and lagged form (X_Y); denominator: male population between ages 10 and 24 years.	June 2001–June 2002	SSP—Secretaria de Segurança Pública de São Paulo IML—Instituto Médico Legal
	Drug-related offences by coordinates and district—standardised drug-related offence ratios (X_1) and lagged form (W_X_1); denominator: area.	1999–2003	'Disque Denuncia'
	Weapons caught by the police—standardised ratios (X_2) and lagged form (W_X_2); denominator: area.	June 2001–June 2002	SSP
	Homicide characteristics by district	June 2001–June 2002	SSP
Demographic and socioeconomic variables	Proportion of: head of household with no income (X_3), (W_X_3)[a];	2000	IBGE—Instituto Brasileiro de Geografia e Estatística DATASUS
	domiciles that are regarded as slum areas (*favelas*) per total number of domiciles per district[b] (X_4);	2004	
	individuals with long-term alcohol problems (X_5)	2004	
Land-use variables	Dummy for centre (centre) 1 = centre, 0 = otherwise (X_6) Proportion of places that are:		Guia mapograph/Multispectral, Guia mais SP, Caixa Econômica Federal
	transport nodes per area (eg bus, underground, railway station, intermunicipal bus station) (X_7);	2000	
	bars and restaurants per domicile (eg *lanchonetes*) (X_8);	2001	
	betting houses (*Casas lotéricas*) per domicile (X_9)[c]	2001	

[a] 1 Minimum salary of approximately US $163 per month in April 2006.
[b] 'Favelas' means "a set of 30 domiciles or more that was or has been built in a plot without land ownership rights. These unplanned settlements often lack basic infrastructure and are densely occupied" (IGBE, 2004). Unfortunately not all identified favelas have the same number of dwellings, so this measure does not fully account for the size effect associated with these areas of extreme poverty.
[c] Betting houses may offer banking services (eg bill payments).